

IMPORTANCE OF HABITAT DIVERSITY IN BOBWHITE MANAGEMENT

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Abstract: Seasonal usage by bobwhites (*Colinus virginianus*) of plant foods affected by prescribed fire management was investigated in southwestern Georgia and northern Florida. The early spring diet changed quickly from greenery to grass seeds (particularly *Panicum* spp.), while fruits from woody plants predominated in summer. The fall-winter diet was dependent on rainfall during flowering and fruiting periods of forbs and on periodic hard mast crops. An inverse relationship existed ($P < 0.05$, $r = -0.54$) between consumption of legumes (Fabaceae) and oak mast (*Quercus* spp.); acorns apparently were preferred when both were available. Habitats comprised of (1) annually-burned grass-forb areas for seed production, (2) infrequently-burned rough for fruit supplies, nesting and escape cover, and (3) hardwood coverts for mast production provide for seasonal requirements and help buffer the effects of drought on food supplies.

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Rank growth of wiregrass (*Aristida stricta*), broomsedge (*Andropogon virginicus*), understory hardwoods and certain other vegetative components of Coastal Plain habitats makes management imperative if high bobwhite populations are to be developed and maintained. The practice of prescribed burning (usually annually) to reduce the density of vegetation, encourage desirable quail foods and increase seed availability is well established (Moore 1957, Komarek 1963, Stoddard 1963, Buckner and Landers 1979). Refinements in managing with fire were presented by Stoddard (1931:407-409) who advocated patchy burning after circling existing thickets with fire lines to insure plant diversity and adequate fruit supplies. However, many bobwhite management areas in the southeastern Coastal Plain now contain extensive areas of annually burned pine (*Pinus* spp.) woods broken only by strips or fields planted to crops. Often, the only woodlands not burned each year are too wet or thinly vegetated to carry a fire.

The importance of maintaining diversity in bobwhite habitat has not been adequately stressed. The purpose of this paper is to present data on bobwhite usage of plant foods affected by prescribed fire management. The benefits of plant community diversity to other bobwhite needs and to other game and nongame species are discussed.

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MATERIALS AND METHODS

Study Areas

Tall Timbers Research Station is an 1130-ha tract in Leon County, northern Florida, a limestone region of hilly terrain. The well-drained soils supported open loblolly and shortleaf pine (*Pinus taeda* and *P. echinata*) stands on most upland sites. Ninety percent of the woodland has been prescribed burned annually for more than 80 years, producing a diverse herbaceous understory. Live oaks (*Q. virginiana*) are common in open uplands and water oak (*Q. nigra*), sweetgum (*Liquidambar styraciflua*), and black gum (*Nyssa*

sylvatica) are common in wetter areas. Corn was grown on the study area; no food patches were planted for quail.

Silver Lake Station is a 1400-ha portion of International Paper Company's Southlands Experiment Forest in Decatur County, southwestern Georgia. Soils are predominantly well-drained, loamy sands of the Orangeburg and Norfolk series; rainfall averages 127 cm annually. Natural longleaf pine (*P. palustris*) stands were the predominant overstory type (69%). Other important communities were sand ridges with sparse longleaf pine and bluejack (*Q. incana*), sand post (*Q. margaretta*) and turkey oaks (*Q. laevis*) (15%), and limestone depressions (either seasonal or perennial ponds) supporting water oaks or aquatic tree species (16%). Wiregrass, bracken fern (*Pteridium aquilinum*), legumes and running oak (*Q. pumila*) dominated the groundstory vegetation on uplands. For many years, management for bobwhites included annual late-winter (usually March) burning and maintenance of bush lespedeza (*Lespedeza bicolor* and *L. thunbergii*) and browntop millet (*Panicum ramosum*) strips. Two- and 3-year-old rough areas for nesting and escape cover, and hardwood coverts for mast production were maintained on uplands and along pond margins.

Nilo Plantation is a 5060-ha tract in Dougherty and Baker Counties, southwestern Georgia. The woodland overstory is composed primarily of longleaf pine and planted slash pine (*P. elliotii*) with scattered oaks (mainly live oaks); this community covered about 60% of the area. Cultivated fields occupied about 10%, open areas and idle fields 20%, and natural ponds 10%. Woody understory plants were primarily blackberry (*Rubus* spp.), sassafras (*Sassafras albidum*), sumac (*Rhus* spp.), and oak sprouts. Herbaceous cover was predominantly grasses (broomsedge, *Panicum* spp., *Sorghastrum secundum* and *Gymnopogon* spp.) and legumes such as partridge peas (*Cassia* spp.), lespedezas, and beggarweeds (*Desmodium* spp.). The area was intensively managed for quail with prescribed burning (averaging 75% of the forested area), planted food patches and small (generally less than 2-ha) cultivated fields.

Data Collection

One hundred eighty-five bobwhites (minimum of 10 each month) were collected at Tall Timbers between March 1968 and February 1969 by shooting and trapping. Three collections, 151, 74, and 80 birds, were taken by shooting on Silver Lake Station between 20 November and 31 December in 1965, 1969, and 1978, respectively. The first 2 collections represented diets following summers of about normal rainfall and the third was taken after a severe drought which affected autumn food supplies. Crop contents were removed, air dried and separated by hand under a dissecting scope. Volume of foods was determined by dry measurement in graduated cylinders.

A total of 21,575 crops were taken from bobwhites harvested on Nilo Plantation during the hunting seasons of 1960-61 through 1978-79. No fewer than 723 crops were examined each year to compare consumption of native foods over the 19-year period. Percentage occurrence only was determined for each food item due to the large number of crops in yearly samples. Regression analyses were performed on data on 7,000 bobwhites from 14 food habits studies (Coastal Plain and Piedmont studies with $N \geq 200$ in Landers and Johnson 1976) to determine the accuracy with which percentage volume could be predicted from percentage occurrence of major foods.

RESULTS AND DISCUSSION

Management for Year-round Diet

The major monthly foods year-round at Tall Timbers are given in Table 1 and Fig. 1. Forty-five additional plant foods, each less than 3.51% of the diet in every month, were identified but not listed. Residual corn and mast from the preceding season formed 82% of the March 1968 diet and 36% in April; green vegetation was the major food in April. Grass seeds were important in late spring; panic grass was the major food in May.

TABLE 1. Major plant foods^a by month of 185 bobwhites collected on Tall Timbers Research Station from March 1968 to February 1969.

Food Item	Percent Volume ^b											
	(10) M	(10) A	(10) M	(10) J	(16) J	(19) A	(20) S	(20) O	(20) N	(20) D	(20) J	(20) F
<i>Quercus</i> spp.	46	13	3					37	35	56	59	57
<i>Zea mays</i>	25	11	2		14	60	52	35	18	7	12	37
<i>Pinus</i> spp.	11	12							39	24	13	2
<i>Cassia</i> spp.	5	7	5					4	5		10	
Leafy vegetation	1	30	8				2			2	1	1
<i>Centrosema virginianum</i>	3	9							1			1
<i>Galactia</i> spp.	6	6	3					2	1		1	1
<i>Trifolium</i> spp.		6										
<i>Scutellaria</i> spp.		5										
<i>Panicum</i> spp.			41	1			7					
<i>Oenothera</i> spp.			7									
<i>Rubus</i> spp.			16	75	13							
<i>Scleria</i> spp.			10	11	6							
<i>Prunus serotina</i>	1		2	10	31	7	2					
<i>Ceanothus</i> spp.					28	1						
<i>Vigna unguiculata</i>				3	7					2		
<i>Schrankia microphylla</i>						6						
<i>Paspalum</i> spp.						18	26	1				
<i>Callicarpa americana</i>						7	5	8				
<i>Nyssa sylvatica</i>							7	6				
<i>Trichostema setaceum</i>								5				
<i>Liquidambar styraciflua</i>										8	3	

^aThese composed a minimum of 97.0% of the total diet each month.

^bPercentage values are rounded to the nearest whole number and foods composing less than 3.51% of the diet in every month are omitted.

^cSample size.

Blackberries were 75% of the June diet and black cherry (*Prunus serotina*) was the most important food in July. Eubanks and Dimmick (1974) found that soft mast formed over 11% of the summer diet of adults in Tennessee and sassafras was the most important summer food of juveniles. Fruit constituted 15% of the foods of bobwhites in Coastal Plain flatwoods (Harshbarger and Buckner 1971), which was more than either grasses or legumes. Fruit was by far the most important food item of adults and the second ranking food of chicks during summer in southern Georgia and northern Florida (Stoddard 1931).

Most fruit and mast producers important to bobwhites are susceptible to damage by fire or have greatly decreased yields the first year after burning; notable examples are sassafras, beautyberry (*Callicarpa americana*), black gum, black cherry (Halls 1977); sweetgum (Hooper 1977); blackberry (Lay 1977) and oaks (Springer 1977). Johnson and Landers (1978) reported that fruit production in slash pine stands peaked (448.4 g/100 m²) the third year after prescribed burning; there was almost no fruit produced during the first growing season after burning (0.5 g/100 m²). Stoddard (1931:407) emphasized the importance of fruit: "Annual burning is never desirable over extensive areas of quail lands because of its injury to the fruit supply."

Side-seed grass (*Paspalum* spp.) ranked second in August and September. Seeds of legumes were taken in every month, with consumption peaking in April when 4 species constituted 28%. Legumes were less than 14% of the volume in all other months (Fig. 1). These data were collected in an unusually dry year (rainfall for first 8 months of 1968 was only 60% of normal) which probably prevented legumes from seeding to their potential.

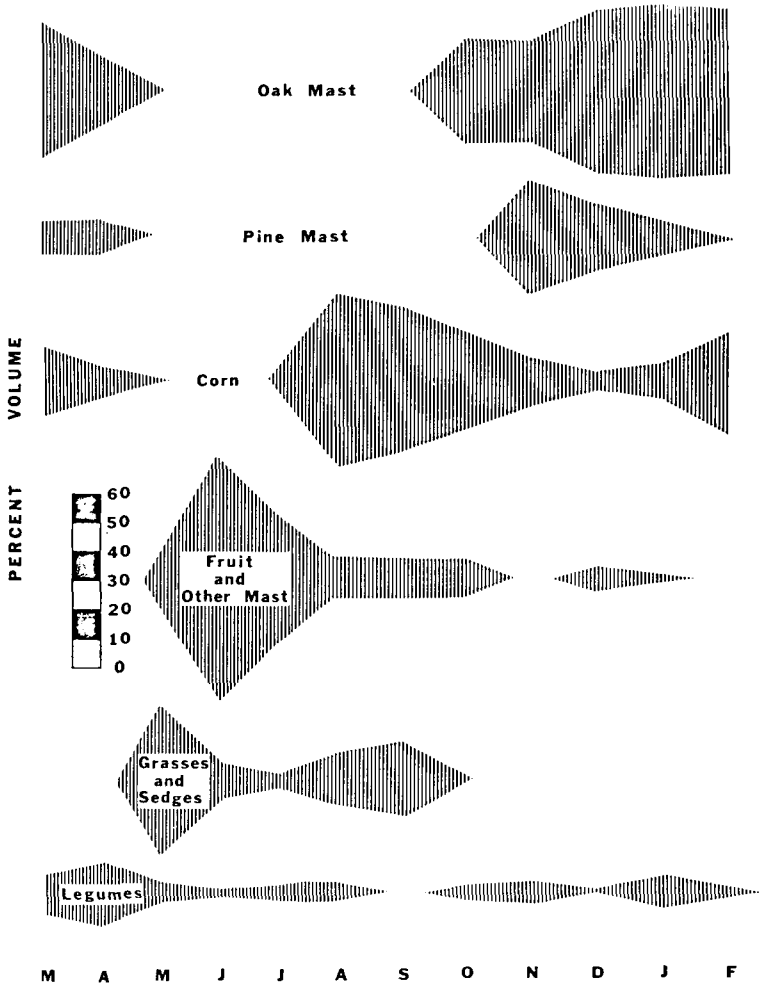


Fig. 1. Major components of the diet of bobwhites from Tall Timbers Research Station during 1968-69.

Acorns were the major food source in October, December, and January. Pine and oak mast together constituted over 70% of the diet from November through January and nearly 60% in both February and March.

Variation in the Autumn and Winter Diet

A comparison of food habits on Silver Lake Station during 3 autumns following summers of differential rainfall is presented in Fig. 2. August-October is the seeding period for partridge peas, beggarweeds, lespedezas and other important legumes in this area. Rainfall for these 3 months in 1965 and 1969 was 55.6 cm and 37.3 cm, respectively, both above normal. Bobwhites made native legumes over 40% of their diet during November-December, 1965; oak mast was noted as a moderate crop and formed about 11%. In 1969, browntop millet and other seed bearers produced high yields; browntop constituted over 56%, but legumes were less than 3% of the diet. Acorns were abundant

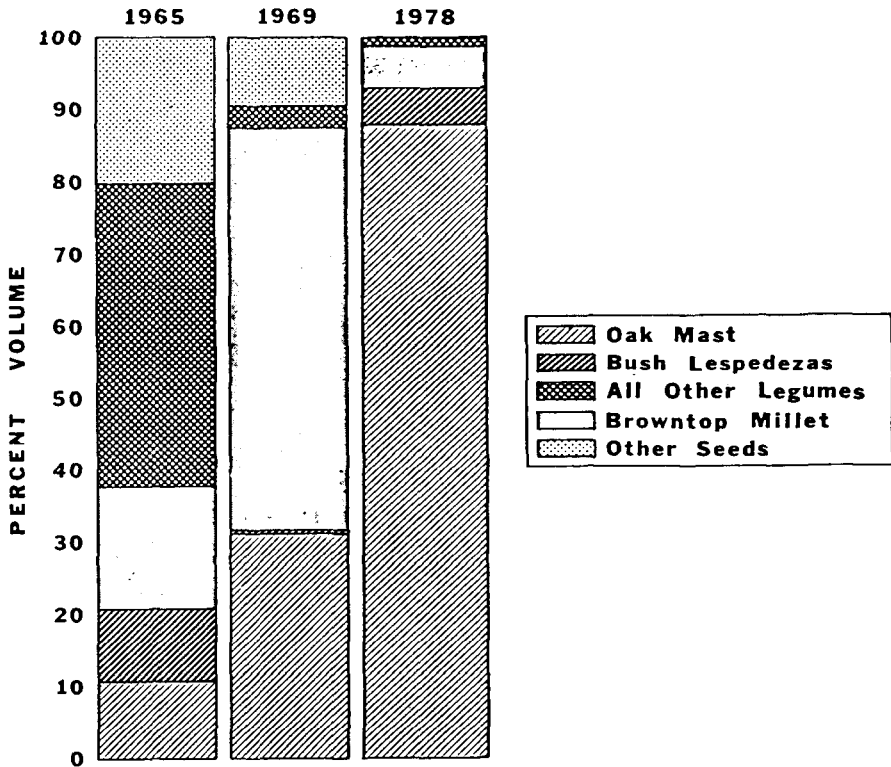


Fig. 2. Comparison of bobwhite diets on Silver Lake Station during 3 autumns of differential rainfall and food availability.

and comprised over 31% of the foods eaten. The more concentrated millet and acorns were apparently preferred to legumes. Weber (1975:690) suggested that legumes, particularly beggarweed, were utilized intensively only when mast was unavailable.

The period August-October, 1978 was the driest for 12 years on record at Silver Lake Station with only 7.0 cm of rainfall for the 3 months, 21.3 cm below normal. Native legumes almost completely failed to seed and formed only 1.1% of the diet (Fig. 2). Bicolor seed production also failed; residual seed from 1977 probably accounted for most or all of the bicolor seeds eaten (4.8%). Oaks (both white and red) produced a bumper mast crop, and acorns comprised more than 87% of the foods consumed. Only rarely does a single native food predominate so strongly in the bobwhite's diet. This is especially significant in years of drought when most seed-producers fail.

A comparison of legume and mast usage during 19 consecutive hunting seasons at Nilo Plantation is given in Fig. 3. During 5 hunting seasons, oak mast occurred in over 20% of the crops examined. Occurrence of beggarweeds and partridge peas exceeded 10% during 4 and 2 fall-winter periods, respectively. Percentage occurrence of native legumes was inversely correlated with that of oak mast ($P < 0.05$, $r = -0.54$). Only in 1960-61 were both acorns and legumes heavily utilized. When oak mast was available, it was apparently the preferred food. In the hunting seasons 1960-61 and 1977-78 legumes were readily available and utilized, but oak mast was still the major native food item. Droughts occurring in the summers of 1968 and 1978 probably resulted in poor seeding of most legumes and increased dependence on acorns.

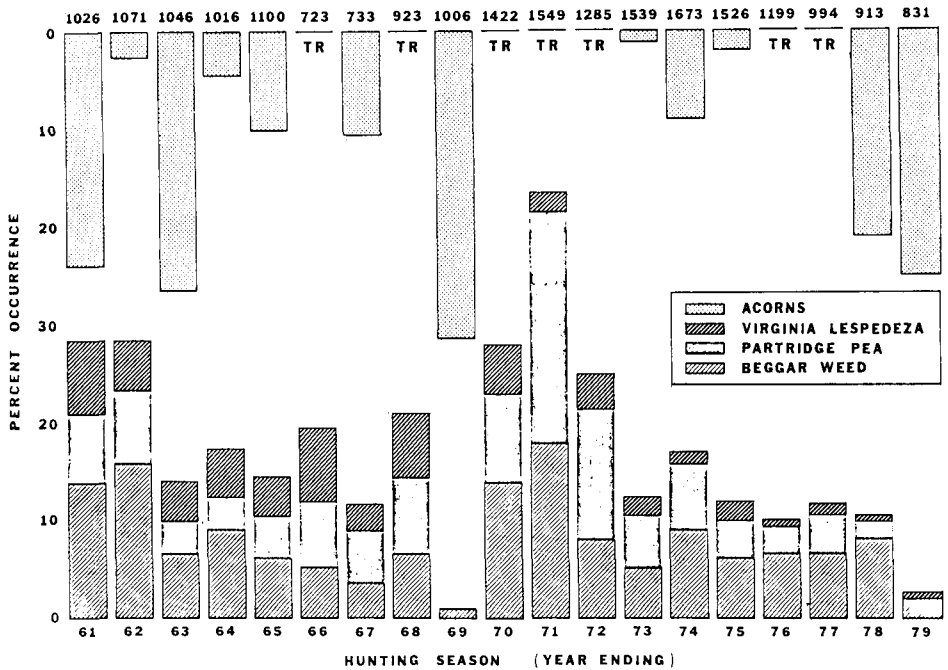


Fig. 3. Usage of major native foods by bobwhites on Nilo Plantation during the hunting seasons of 1960-61 through 1978-79. Numbers at top are sample sizes.

Predicted percentage volumes of acorns and native legumes at Nilo are given in Fig. 4. Regression analyses revealed that percentage volume of acorns, beggarweeds, native lespedezas and partridge peas in other studies (see MATERIALS AND METHODS) were highly correlated with percentage occurrence ($P < 0.01$, $r = 0.97, 0.95, 0.75, 0.62$, respectively). Percentage volume was thought to better represent relative importance of foods. Oak mast contributed a greater volume than all native legumes combined in 9 of 19 years.

Landers and Johnson (1976) reported that oak mast was in the first or second highest significance class by volume in 67% of the published food habits studies in the Coastal Plain and Piedmont. Many studies have shown acorns to be the most important native food in good mast years (e.g. Davison 1942, Goodrum 1959, Eubanks and Dimmick 1974). Others have emphasized the importance in bobwhite management of maintaining a mast-producing hardwood component (Rosene 1969, Weber 1975).

MANAGEMENT IMPLICATIONS

Hard mast and fleshy fruit comprised more than 50% of the diet during 8 of 12 months in 1968-69 at Tall Timbers. Acorns were the most important native food at Nilo Plantation during 9 of 19 years and at Silver Lake during 2 of 3 autumns. These data clearly demonstrate the importance of foods from woody plants which are suppressed by annual burning. More complete burning over large areas results in the loss of mast potential and increases the need for plantings and supplemental feeding.

Very low rainfall during the critical period for legume seed production has occurred at Silver Lake during 5 of the past 12 years. This recurring possibility of almost complete legume seeding failures makes buffer food sources, such as mast bearing species,

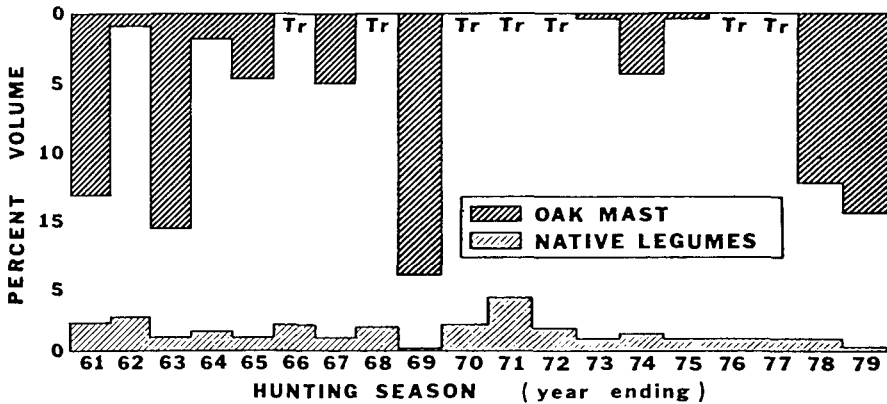


Fig. 4. Calculated volume percentages of major native foods of Nilo Plantation bobwhites from 1960-61 to 1978-79. Volume of each food was determined from occurrence using regression equations developed from 14 other studies with samples of $N \geq 200$ (see MATERIALS AND METHODS).

especially important during dry years. Acorn production also is irregular, but is not inhibited by drought.

Other management techniques, in addition to fire, can be used to supplement food production. Buckner and Landers (1979) showed that both species diversity and total seed production of native herbs was higher in disked areas than those annually burned at Silver Lake. Stoddard (1931) advocated wide, disked fire lines to encourage natural herbaceous species.

Aspects of bobwhite management other than providing food justify maintenance of diversity. Simpson (1972) has shown at Silver Lake and Nilo, and Dimmick (1971) at Ames Plantation that areas unburned for 1 year were preferred bobwhite nesting cover. Providing these 2-year roughs helps distribute nests more evenly and sparsely, reducing losses from nest predation. Thickets such as blackberry tangles are also important cover for escape from avian predators and are essential in open woodlands (Stoddard 1931:117, 371). Bobwhite habitat can be enhanced by encouraging diverse vegetational types including open woodlands, cultivated and fallow ground, thickets and scattered mast producing areas.

The consensus of plantation managers at a Tall Timbers bobwhite seminar in Thomasville, Georgia (March, 1979) was that populations were high, but hunter success on typical hunting routes was poorer than usual. Coveys were often in unburned thickets along stream courses because of the excellent acorn crop. Planned hardwood coverts would aid in holding coveys on upland sites and increase hunter success.

Other games species would also benefit from encouraging mast production and some understory development in small units scattered through otherwise continuous pine stands. In the Southeast, a good mast supply and diversity of habitat types are highly beneficial to turkeys (*Meleagris gallopavo*) (Korschgen 1967, Speake et al. 1975). Deer (*Odocoileus virginianus*) (Harlow and Jones 1965, Segelquist et al. 1969), squirrels (*Sciurus carolinensis* and *S. niger*) (Halls 1977) and nearly 100 other species of birds and mammals (Martin et al. 1951) are dependent to some degree on acorns. Annually burning southern pine-hardwood forests can reduce the understory production of mast by 70% or more (Lay 1955, Johnson and Landers 1978).

Both species richness and density of songbirds increase with increasing stand complexity (Hooper and Crawford 1969, Roth 1976). A hardwood component in longleaf-slash (Wood and Niles 1978) and loblolly-shortleaf (Meyers and Johnson 1978) pine forests is necessary to maintain diverse bird communities. Harlow and Belling (1961) and Noble and Hamilton (1976) have emphasized that annual burning of large expanses of pine forests is deleterious to most nongame bird species.

Prescribed burning is a necessary practice in both forestry and wildlife management of Coastal Plain pine stands. The purpose of this paper is not to de-emphasize the importance of prescribed burning, but rather to stress the need for habitat diversity within annually burned pine woods. By judicious use of prescribed burning, effective bobwhite management can be highly compatible with management schemes for many other game and nongame species.

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